depth QA is performed for all components of the RT chain. Without a more thorough understanding of how these uncertainties impact treatment effectiveness, advanced techniques remain limited by this necessary cautious and safety-based approach. The aim of this pilot study was to develop a method to investigate how treatment delivery uncertainties affect patient dose distributions and to apply this method to a limited dataset of lung SABR plans.

Materials and Methods: The Pinnacle[3] TPS (version 9.8) was used to create reference 6 MV step and shoot IMRT plans for a lung SABR dataset on an Elekta Synergy linac with the MLCi MLC. Dose prescriptions were 50Gy/5fx, 54Gy/3fx and 48Gy/4fx for central lung, free and near-rib tumours, respectively. Copies of the reference treatment plans were modified using in-house code to generate a series of systematic 'error-introduced' plans. The scripts altered the values of three beam delivery parameters (gantry angle, collimator angle and MLC leaf positions) across all control points. Gantry and collimator angles were changed from their reference values by ±1, 2 or 5 degrees. Changes to the planned MLC leaf positions were applied equally to all leaves such that each was shifted from its reference position by ±1, 2 or 5 mm. Each error-introduced plan was then read back into Pinnacle and a dose calculation was performed on the reference patient anatomy. Target DVH metrics including V95%, V100% and V105% and OAR DVH metrics including Dmax for the heart and spinal column were extracted from all plans and compared to quantify differences between the reference and error-introduced dose distributions.

Results: The PTV V100% and V105% tended to decrease with increasing magnitude of MLC leaf shift, with average decreases of 10 and 20% occurring respectively for MLC shifts of 5 mm. Dmax of the heart and spinal column increased up to 16 and 165% respectively when the modified gantry angles positioned incident beams closer to these OARs than in the reference plan. Collimator angle variation typically resulted in smaller deviations for all DVH metrics than variations in gantry angle or MLC leaf position.

Conclusions: A method to investigate the impact of treatment delivery uncertainties on patient dose distributions has been developed and applied to an initial cohort of lung SABR plans. Target coverage was typically compromised more by changes in MLC leaf positions than gantry or collimator angle. OARs in close proximity to incident beams were most sensitive to changes in gantry angle. Work is ongoing to extend this study to a wider set of plans with the aim of quantifying site- and technique-specific estimates of treatment delivery uncertainties on advanced RT techniques.

EP-1443

Enabling the Swiss Monte Carlo Plan (SMCP) to assess dose rate

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Purpose/Objective: Dose rate is known to be an essential factor in radiobiology. As modern radiotherapy delivery techniques such as Volumetric Modulated Arc Therapy (VMAT) introduce variability to the dose rate, it is important to assess the changes in dose rate in VMAT treatment plans. Thus, in this work the SMCP framework was extended to assess dose rate during the application of a VMAT treatment plan.

Materials and Methods: The SMCP framework is interfaced to the Treatment Planning System (TPS) Varian Eclipse and is used to calculate dose and dose rate distributions. For the latter, SMCP splits the VMAT plan file into individual plan files, each representing an arc segment between two consecutive DICOM control points. Each of these files contains the gantry angle and Multi-Leaf Collimator (MLC) position data of their respective arc segment, leaving other plan data untouched. In a next step, dose distributions are calculated in units of cGy per Monitor Unit (MU) for each arc segment independently by means of the SMCP on a Linux cluster. Resulting dose in each voxel is then multiplied by its corresponding MU rate per second as received from Eclipse, yielding dose rate distributions per arc segment.

This approach was applied to a head and neck cancer patient. For this purpose, a full rotation VMAT arc plan to deliver 2 Gy per fraction as mean dose to the PTV was used. Machine dose rate was set to 600 MU per minute in this plan. For the full 178° VMAT, 399 MU were applied over a total time of 74.7 s. This led to 177 arc segments, for which the dose distributions were calculated to a statistical uncertainty of about 1% using 0.25cm³ calculation grid voxels. Data was plotted in terms of dose rate versus time within the calculation volume and PTV.

Results: For the head and neck case selected, dose rates per segment reached up to 12.16 cGy/s within the full calculation volume. Within the PTV, the range extended from 0.04 to 12.16 cGy/s. Mean PTV dose rate over the whole arc was 2.08 cGy/s. Maximal dose rate per segment within the PTV ranged from 3.6 cGy/s in arc segment 125 to 12.16 cGy/s in segment 65, while minimal PTV dose rate per segment ranged from 0.04 cGy/s in segment 118 to 0.18 cGy/s in segment 64.

Conclusions: The SMCP framework is now able to assess the dose rate for each voxel in a calculation volume. A substantial variation of dose rate per segment was observed in the head and neck cancer VMAT treatment plan considered.

EP-1444

Monte Carlo verification of IMRT based on DVH-metrics. Initial results

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Purpose/Objective: The aim of this work is to establish an alternative method to evaluate differences between IMRT dose distributions; comparing Superposition Collapsed Cone (SCC) TPS dose calculations to Monte Carlo (MC) redundant calculations. MC is considered our reference calculation provided that is properly set up and validated with experimental measurements. We present here initial results for quantitative comparison of dose distributions based on DVH parameters. Gamma evaluation has been the most accepted tool during the last decades [1], but this kind of